

**PCT**  
**NOTIFICATION OF ELECTION**  
(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
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CP2/5C24  
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in its capacity as elected Office

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International application No. PCT/NO00/00279	
International filing date (day/month/year) 24 August 2000 (24.08.00)	
Priority date (day/month/year) 24 August 1999 (24.08.99)	
Applicant SELE, Arne et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
08 February 2001 (08.02.01)

☐ in a notice effecting later election filed with the International Bureau on:

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☐ was not

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(19) World Intellectual Property Organization  
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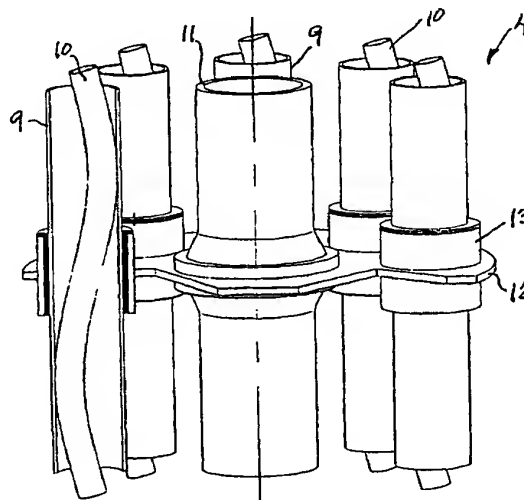
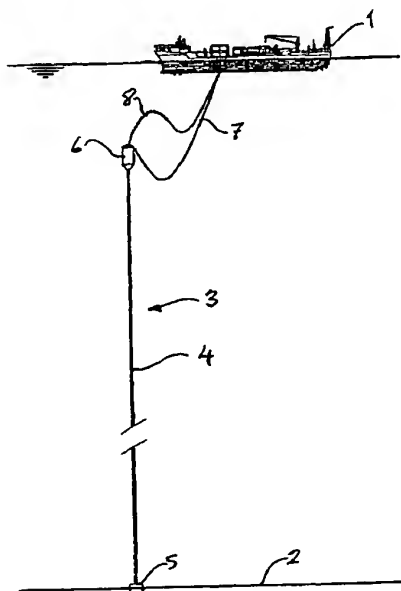
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19994094 ✓ 24 August 1999 (24.08.1999) **NO**
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(54) Title: **A HYBRID RISER CONFIGURATION**



(57) Abstract: Hybrid riser configuration comprising a plurality of steel riser pipes (10) substantially inserted in aluminium guide conduits (9), with buoyancy means (6) and tethering tension means, the guide conduits (9) and the riser pipes (10) being rigidly connected to a base (5) anchored to the ocean floor. The guide conduits (9) serve as the tethering tension means and as radial constraint for the respective riser pipe (10) therein to allow the riser pipe to buckle in elastic deformation (Euler) to form a spiral when expanding due to service pressure and temperature. A method for installing the riser configuration is also disclosed.

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## A HYBRID RISER CONFIGURATION

## FIELD OF THE INVENTION

5 The present invention relates to a hybrid riser configuration, primarily for offshore hydrocarbon services, as defined in the preamble of claim 1.

## BACKGROUND

10

The hybrid riser concept has developed from top tension risers. The principal feature is that it accommodates relative motion between a floating structure and a rigid metal riser by connecting them with flexible jumpers. The first hybrid riser installed, and so far the only, was a single riser anchored to the structure with a tensioned cable. Current concepts mainly involve multiple risers with tension provided by submerged buoyancy anchored by a tether.

20

The principle advantage of hybrid risers tensioned by submerged buoyancy is that they are much less exposed to wave induced cyclic loads and are not excited significantly by vessel motion either. The challenge of such designs is to accommodate the relative deformation between the central tether and the risers. The risers are subjected to temperature, internal pressure, and lateral deflection, which give rise to relative deformation.

25

30 Several solutions accommodating these relative deformations can be envisioned. The most efficient solution will depend on project specific conditions, and there may not be one single design solution which is more cost optimal in all cases. The most attractive solution will be the one minimizing the major cost drivers which are syntactic foam for insulation, flexible flowline connectors, flexible jumpers, offshore assembly, tow-out, and offshore installation.

35

## OBJECT OF THE INVENTION

The object of the present invention is to accommodate relative expansion of the riser tubes in a simple and reliable manner, and to reduce cost and risk exposure in connection with fabrication and installation of a hybrid riser configuration.

## BRIEF DISCLOSURE OF THE INVENTION

These and other objects are obtained by means of an arrangement characterised in the features mentioned in claim 1. The invention also provides a method as defined in claim 6.

Further advantages and embodiments are defined in the dependent claims and the following disclosure and figures relating to exemplifying embodiments of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an elevation view of a surface vessel connected to equipment on the ocean floor by a hybrid riser embodying the present invention,

Figure 2 is a fragmentary perspective view, partly in section, of a middle portion of the riser in Figure 1,

Figure 3 is a fragmentary perspective view of the bottom part of the riser in Figure 1,

Figure 4 is a vertical cross-section through an end connection for use in the riser in Figure 1, and

Figure 5 is a schematic elevation view illustrating a method for installing the riser in Figure 1.

## DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the drawings, Figure 1 shows a surface vessel 1, e.g. a production ship for crude oil, connected to equipment (not shown) on the ocean floor 2 through a hybrid riser generally designated 3 and embodying the present invention. The riser 3 comprises a riser tower 4 connected at its lower end to a base 5 at the ocean floor 2 and at its upper end to a so-called soft tank buoyancy means 6 keeping the riser tower 4 in sufficient tension to avoid global buckling thereof.

At the buoy 6 the multiple risers of the tower 4 are connected to flexible jumper hoses 7, 8, the jumpers 7 carrying produced crude oil to the production ship 1 and the jumpers 8 carrying treated product from the ship 1 to an oil export system.

Details of the riser tower 4 are shown in Figures 2 and 3, Figure 3 showing the lower part of the tower connected to the base 5 and Figure 2 showing a section of the tower, e.g. somewhat like the upper part in Figure 3, partly broken away and partly in cross-section.

The tower comprises eight guide conduits 9, preferably made of aluminium or an aluminium alloy such as Al 6082, five of which are shown in Figure 2. A plurality of these conduits, e.g. seven of them, contains a riser pipe 10 of substantial smaller diameter, as shown in the sectioned conduit in the left part of Figure 2. The conduit not containing a riser pipe may contain an umbilical and other service lines leading to equipment on the ocean floor. The diameter of the guide conduits 9 and riser pipes 10 may be 20 cm and 10 cm, respectively.

Centrally located in the tower 4 is a pipe 11, for instance made of steel, that may serve as an export conduit for products from the production ship 1. The central pipe 11

carries a number of guide plates 12 arranged at regular intervals along the riser tower 4 and clamped between connecting flanges of the central pipe 11, the guide plates carrying guide sleeves 13 for the guide conduits 9 to keep  
5 the conduits apart when deflected by current forces. The guide sleeves may contain a low friction material to facilitate axial movement of the guide conduits 9 with respect to the guide plate 12.

10 The soft buoyancy tank 6 constituting the top of the riser configuration according to the invention supports the guide conduits 9 and their riser pipes 10. The upper part of the guide conduits is provided with an increasing wall  
15 thickness so as to act as a stress joint. This stress joint is rigidly connected to the tank 6. A similar type of stress joint constitutes the lower part of the guide conduits 9, extending e.g. between the guide plate 12 and the base 5 shown in Figure 3. Consequently, the guide  
20 conduits 9 are rigidly connected to the base 5, thus avoiding the need for expensive flexible connections in this area.

Also the internal riser pipes 10 are rigidly connected to the base 5 and internal piping leading to respective  
25 external connections 14 spaced along the periphery of the base 5. The fixed base 5 and rigid connections 14 are cost efficient in that they permit conventional pull-in and connection of pipelines.

30 A principal feature of the present invention is the dual purpose served by the aluminium guide conduits 9. Firstly, the guide conduit will restrain the steel riser pipe 10 confined therein so that it can be allowed to buckle in elastic deformation when subjected to elongation caused by  
35 high temperature and internal pressure. This buckling occurs in two orthogonal planes with a 90° phase lag, thus forming a spiral in accordance with the Euler equation. This spiral form assumed by the riser pipe 10 is suggested

in Figure 2. As a result, this controlled buckling will permit the use of a relatively thin-walled riser pipe without the need for separate tensioning means. Furthermore, the individual riser pipes 10 in the riser configuration according to the invention may operate at different pressures and temperatures and, consequently, different degrees of elongation, without causing support problems since the different elongations will simply lead to varying wave lengths of the spirals.

Secondly, the aluminium guide conduits 9 serve as tethers for the buoyancy tank 6, thus doing away with the dedicated tethers used in prior art hybrid risers. Furthermore, the relatively inexpensive aluminium pipes provide necessary buoyancy at a much lower cost than the foam buoyancy otherwise required for tow-out and installation.

In normal service, the guide conduits 9 may be pressurized with a gas like air or nitrogen to prevent implosion from occurring due to the external hydrostatic pressure. It is also envisioned to fill the annular space between the riser pipe 10 and guide conduit 9 with a gel, e.g. a paraffin gel, to reduce the heat transfer between the riser pipe 10 carrying hot produced oil and the cooler guide conduit 9 having the temperature of the surrounding sea water. Several measures may be taken to avoid corrosion of the materials in the annular space, like providing the riser pipe 10 with a coating of a polymer material or spray-coating it with aluminium. The inside of the aluminium (alloy) guide conduit 9 may be subjected to an anodising process. Also, spacer ring of an insulating material may be installed at regular intervals inside the conduit to prevent metal contact with the riser pipe.

In general, while the aluminium guide conduits may be provided with sufficient corrosion allowance to allow them to act as anodes for steel end fittings of riser pipes and flexible jumpers, it is simpler to provide sacrificial

anodes to protect the entire structure. Careful analysis has shown that, contrary to common prejudice within the industry, it will be quite safe to mix steel and aluminium in a sub-sea structure like that of the present invention.

5

Referring now to Figure 4, the lower termination of a riser pipe 10 and its guide conduit 9 at the base 5 is shown. The tapering wall thickness of the stress joint forming the lower part of the guide conduit 9 will be apparent from the figure. Both the conduit 9 and riser pipe 10 are provided with compact end flanges, which are bolted to the flange 15 of a connecting pipe cast into the base 5 and leading to one of the connections 14 shown in Figure 3. The compact flanges may have a seal system (not shown) which allows interfacing of different materials without giving rise to galvanic corrosion or crevice corrosion on the mating faces.

20

Figure 4 also shows a valve 16 connected to the annulus between the conduit 9 and pipe 10. This valve controls the differential pressure between the annulus and the surrounding sea water and is set such that it will allow ingress of water into the annulus well before the differential pressure becomes high enough to crush the guide conduit 9. Also, the valve 16 serves to permit flow out of the annulus if the pressure therein should exceed the external pressure by a predetermined amount, e.g. to permit purging the annulus of sea water that may have entered the annulus. This may occur during installation of the riser configuration, as will be explained below.

30

The upper termination of the guide conduit 9 and riser pipe 10 may be quite similar to that shown in Figure 4, although the concrete base will of course be replaced by some other suitable structure on the soft tank 6 obvious to the skilled person.

35



The riser tower according to the invention may preferably be fabricated on a roller bed or rail bed from which it can be launched. The connections to the buoyancy tank 6 and foundation 5 are made during the launching process. The riser will be made nearly neutrally buoyant. To achieve this, at least some of the guide conduits 9, and preferably all the riser pipes 10, will be used for buoyancy. A heave compensator will be provided at the buoyancy tank, which will be flooded so as to act as a clump weight.

10

The tow-out will initially be performed as a surface or near surface tow. In deeper water it may be lowered and completed as a sub-surface tow to reduce the effect of wave forces, as illustrated in Figure 5. Here, surface vessels 17 provide a substantial tension in the towing wires 18, thus creating sufficient tension in the tower 4 to prevent its net buoyancy, whether slightly negative or positive, from severely bending the tower. When the tow reaches the installation site, the towing wire at the base 5 end is paid out so that the tower 4 is slowly up-ended while being suspended in the heave compensated towing wire 18 at the tank 6 end. When the base end of the tower has reached a certain depth, the hydrostatic pressure will be such that the differential pressure valves 16 (Figure 4) will open to let water into the annulus between the guide conduit 9 and riser pipe 10 in order to prevent the external hydrostatic pressure from imploding the conduits 9 during the remainder of the decent towards the ocean floor 2.

Once the riser tower is vertical, the base end towing wire is released and lowering will continue from the top end to allow the base 5, which may be provided with a suction skirt, to penetrate the mud-line, followed by application of suction to complete the installation of the base. When the base 5 is in place, the buoyancy tank 6 is filled with compressed air or other gas to purge the ballast water and provide tension in the combined guide conduits and tethers 9. The final step of connecting the flexible jumper hoses

7 and 8 between the buoyancy tank 6 and the production tanker 1 to complete the hybrid riser, does not form part of the present invention.

5 Based on historical data from the prior art, the principal risk during tow-out and installation is loss of temporary buoyancy. In the present invention, temporary buoyancy is not required since sufficient buoyancy is provided by the structure itself. Each of the guide conduits 9 consists of  
10 two compartments, the steel riser pipe 10 inside and the annular space between the riser pipe and the inside of the guide conduit. During tow-out and installation, and also in service, the flooding of one compartment can be allowed without consequence to the design.

15 An alternative approach to installation, although not considered the most beneficial, is offshore assembly from a drilling platform. In this case, the riser base 5 is initially hung off in a spider on the cellar deck. Guide  
20 conduit and riser pipe sections are then installed with the derrick of the drilling platform.

It will be understood that the present invention is not limited to the exemplifying embodiments shown in the  
25 drawings and discussed above, but may be varied and modified by the skilled person within the scope of the invention defined by the appended claims. Furthermore, it will be understood that the present invention provides a number of significant advantages which may be summarised as  
30 follows:

- Use of costly buoyancy materials such as syntactic foam are eliminated.
- Use of temporary buoyancy materials are not required  
35 during any phase of tow-out or installation.
- Aluminium conduits are light in weight, further reducing the requirement for buoyancy.

- Aluminium conduits give cathodic protection to other parts of the rigid riser structure.
- The use of flexible pipes and connections to pipelines at the riser base are eliminated. Direct pull-in of  
5 rigid flowlines and pipelines may be achieved using field proven equipment.
- The central tubular member in the rigid riser, used as a tensile structural member in former examples of hybrid risers, is eliminated. Instead, one or more export  
10 riser pipes may be included in centre of the structure.
- Tow-out and installation of the rigid riser portion can now be achieved in a single operation. The concept is also adaptable for installation from a drilling platform, or similar.
- 15 • All offshore assembly work may be eliminated.
- Hot water may be circulated through the conduits to heat the riser pipes.

## C L A I M S

1. A hybrid riser configuration having a submerged tower  
5 (4) comprising a plurality of riser pipes (10) substantially inserted in guide conduits (9), and also having buoyancy means (6) and tethering tension means, the riser pipes (10) and guide conduits (9) being connected to a base  
10 (5) anchored to the ocean floor,  
c h a r a c t e r i s e d i n that a plurality of the guide conduits (9) are acting as multiple tethers, each guide conduit (9) further acting as a radial constraint in elastic deformation (Euler) of the riser pipe (10) inside.
- 15 2. A hybrid riser configuration according to claim 1,  
c h a r a c t e r i s e d i n that the riser pipes (10) and guide conduits (9) are rigidly connected both to the base (5) and the buoyancy means (6) of the riser configuration.
- 20 3. A hybrid riser configuration according to claim 1 or 2, c h a r a c t e r i s e d i n that the material of the guide conduits (9) comprises aluminium or a similar light metal.
- 25 4. A hybrid riser configuration according to any one of the preceding claims,  
c h a r a c t e r i s e d i n that it is protected by sacrificial anodes.
- 30 5. A hybrid riser configuration according to any one of the preceding claims,  
c h a r a c t e r i s e d i n that during tow-out and installation, the guide conduits (9) provide necessary  
35 buoyancy to make the riser configuration, except the base (5) and buoyancy means (6), near neutrally buoyant.

6. A method for installing a riser configuration having a submerged tower (4) comprising a plurality of riser pipes (10) substantially inserted in guide conduits (9) and also having a buoyancy tank (6) and gravity base (5) connected by said riser pipes (10) and guide conduits (9), comprising the steps of:

- fabricating a bundle (4) of guide conduits (9) and riser pipes (10) on a roller bed or rail bed from which it can be launched,
- 10 - connecting the buoyancy tank (6) and gravity base (5) to opposite ends of said bundle,
- sealing at least a plurality of the guide conduits (9) and riser pipes (10) of the bundle (4),
- launching the resultant structure and connecting the 15 buoyancy tank and gravity base ends of the structure to respective towing vessels (17) via towing wires (18),
- flooding the buoyancy tank (6) to provide it with substantial negative buoyancy so that both the tank (6) and the base (5) will act as clump weights,
- 20 - towing the structure (4,5,6) to the offshore location for its installation as a sub-surface tow while maintaining sufficient angle and tension in the towing wires (18) to maintain substantial tension in the pipe bundle (4),
- lowering the base (5) end of the structure (4-6) by 25 paying out the towing wire connected to the base (5),
- permitting water to enter the spaces formed between the riser pipes (10) and their respective guide conduit (9) when the base (5) has reached a predetermined depth in order to limit the differential pressure across the wall of 30 the guide conduits (9),
- continuing lowering the base end of the structure until the structure is perpendicular and suspended from the towing wire (18) connected to the buoyancy tank (6), and
- lowering the structure to allow the base (5) to 35 penetrate the bottom (2) mud-line and anchoring the base to the ocean floor, and removing the water ballast and towing wire (18) from the buoyancy tank, thus providing tension in the guide conduits (9).

7. A method according to claim 6, wherein a motion compensating system is employed in the towing wire (18) between the buoyancy tank (6) and surface vessel (17).

5

8. A method according to claim 6 or 7, wherein the guide conduits (9) are fabricated by welding together sections of aluminium pipe using friction stir welding.

10 9. A method according to any one of claims 6-8, wherein said guide conduits (9) are made by joining sections of aluminium pipe which are made with a longitudinal seam welded by means of friction stir welding.

15 10. A method according to any one of claims 6-9, wherein at least some of the annular spaces between the riser pipes (10) and the corresponding guide conduits (9) are filled with a gel after expelling any water having entered said spaces during installation of the structure.

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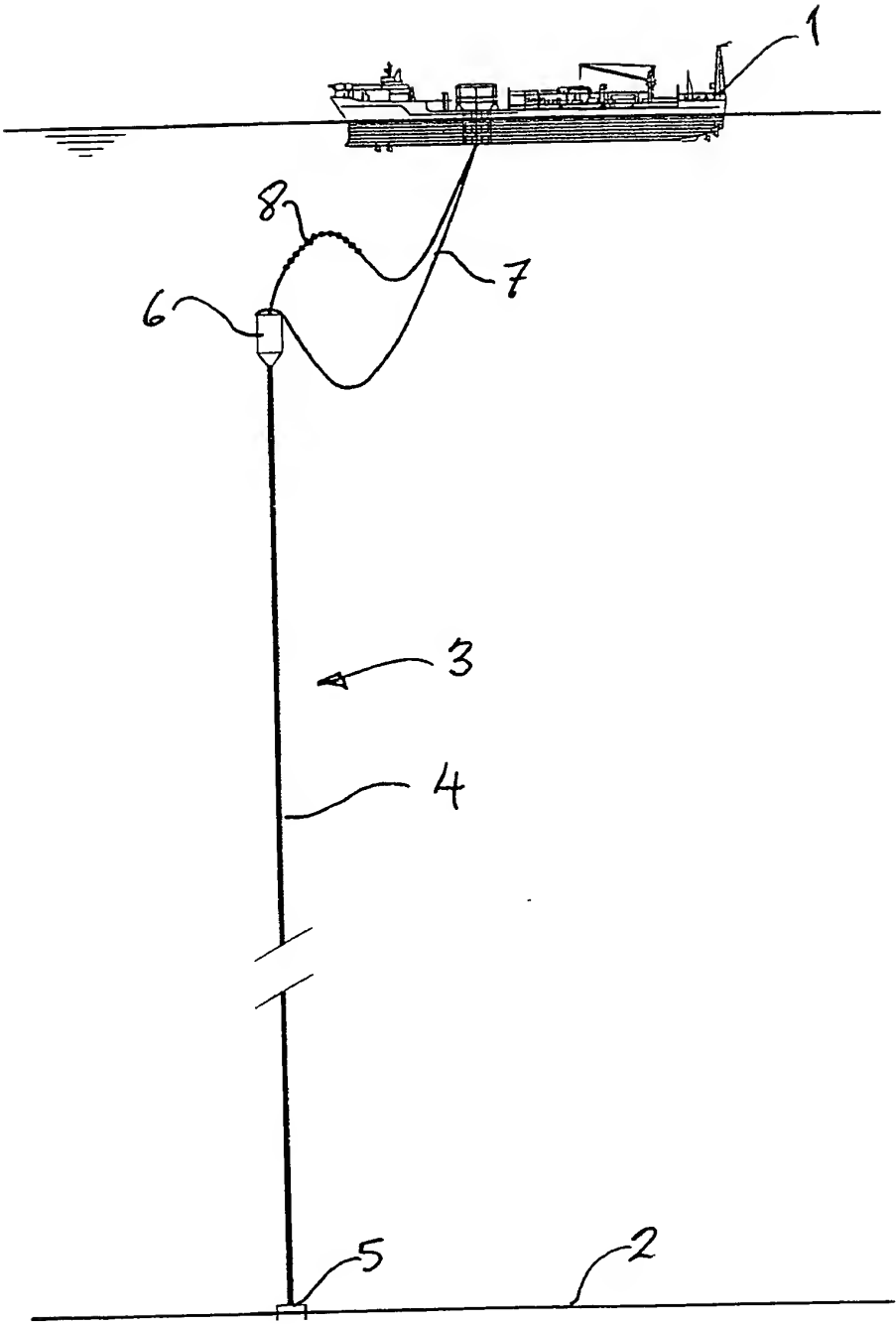


Fig. 1

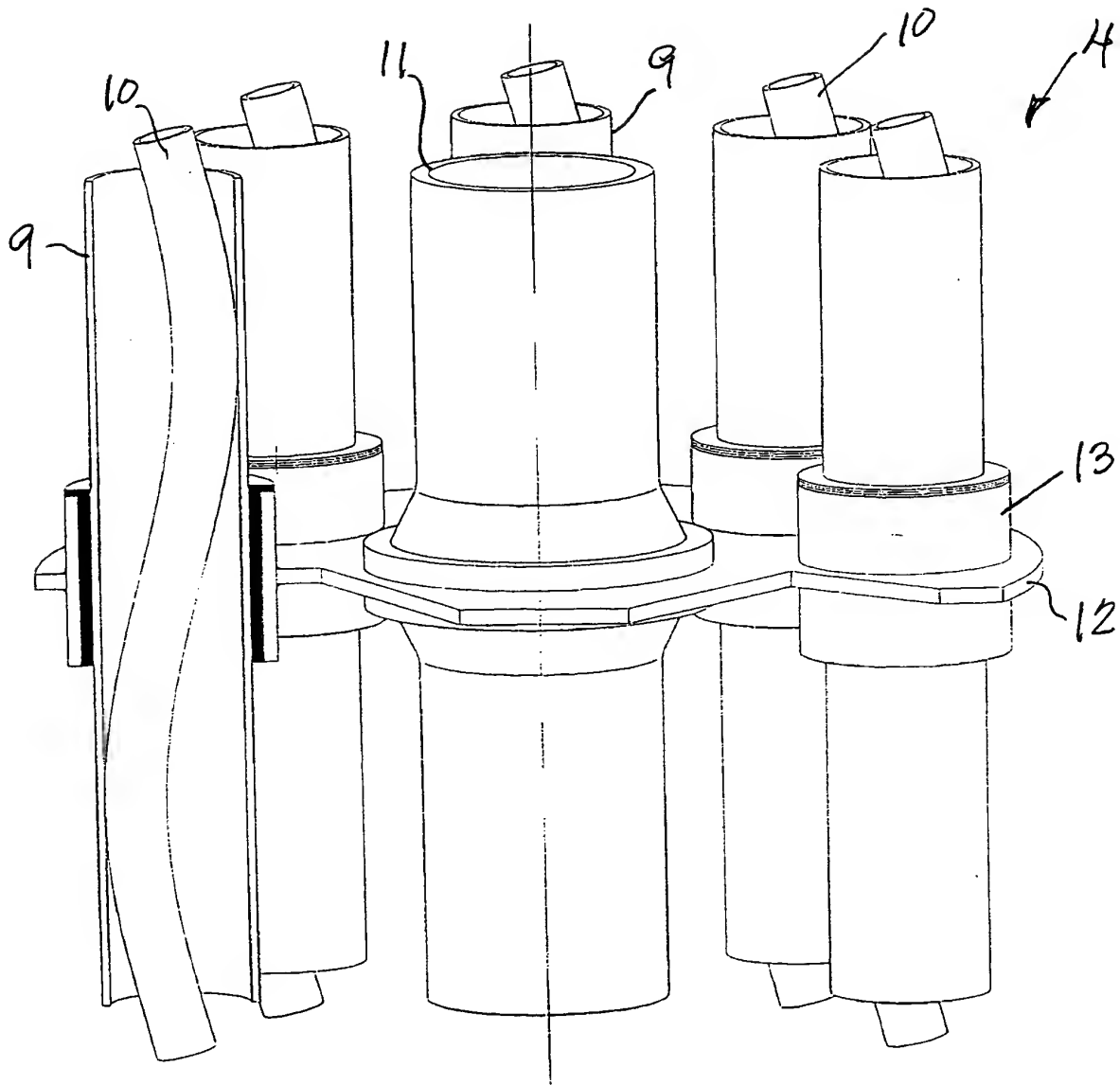
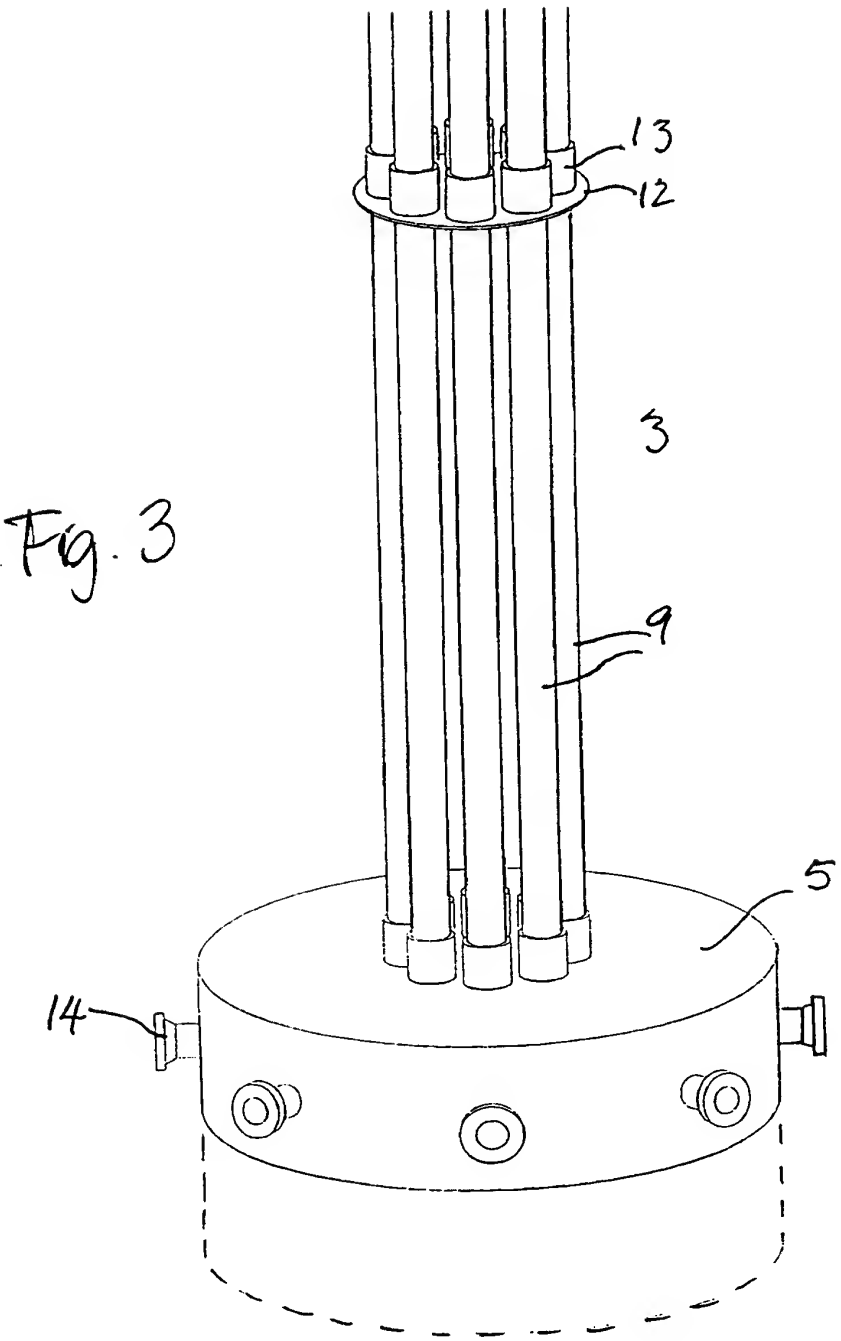


Fig. 2





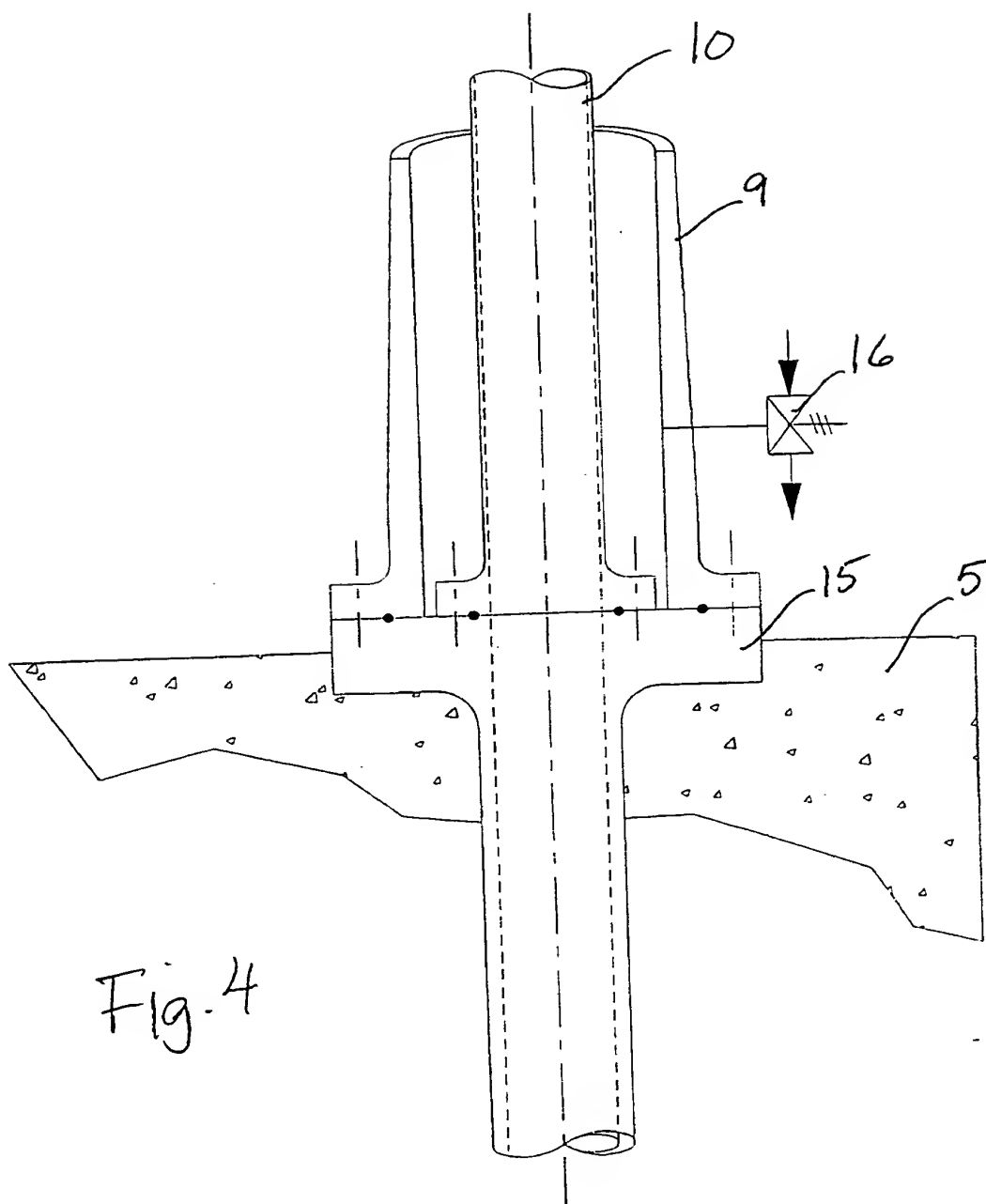


Fig. 4

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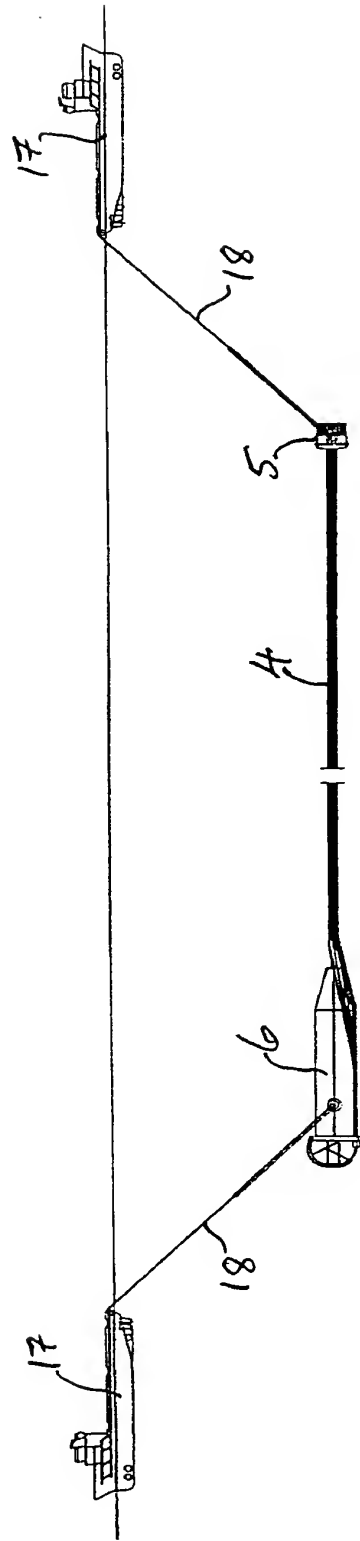


Fig. 5

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 00/00279

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 17/01, E21B 43/01

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2188394 A (THE BRITISH PETROLEUM COMPANY P.L.C.), 30 Sept 1987 (30.09.87) --	1-10
A	GB 2330157 A (BLUEWATER TERMINAL SYSTEMS N.V.), 14 April 1999 (14.04.99) --	1-10
A	EP 0200308 A1 (CAMERON IRON WORKS, INC.), 5 November 1986 (05.11.86) --	1-10
A	US 4332509 A (REYNARD ET AL), 1 June 1982 (01.06.82) -- -----	1-10

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

30 November 2000

Date of mailing of the international search report

04-12-2000

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## INTERNATIONAL SEARCH REPORT

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PCT/NO 00/00279

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 17/01, E21B 43/01

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Date of the actual completion of the international search

30 November 2000

Date of mailing of the international search report

04-12-2000

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/NO 00/00279

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
GB	2188394	A	30/09/87	GB 8607393 D	00/00/00
				GB 8706906 D	00/00/00
GB	2330157	A	14/04/99	BR 9806610 A	25/04/00
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				ES 8102653 A	16/04/81
				FR 2459420 A,B	09/01/81
				GB 2052005 A,B	21/01/81
				NO 160389 B,C	02/01/89
				NO 801808 A	19/12/80

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 12 DEC 2001

WIPO PCT

Applicant's or agent's file reference 140698/LS/KR	<b>FOR FURTHER ACTION</b>		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/NO00/00279	International filing date (day/month/year) 24/08/2000	Priority date (day/month/year) 24/08/1999	
International Patent Classification (IPC) or national classification and IPC E21B17/01			
Applicant AKER RISER SYSTEMS AS et al.			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 8 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  08/02/2001	Date of completion of this report  10.12.2001
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Morrish, S  Telephone No. +49 89 2399 7220



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NO00/00279

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-9 as originally filed

Claims, No.:

1-10 as originally filed

Drawings, sheets:

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:



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☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):  
*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**IV. Lack of unity of invention**

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.  
☐ paid additional fees.  
☐ paid additional fees under protest.  
☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.  
☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.  
☐ the parts relating to claims Nos. .

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims	1-10
	No:	Claims	
Inventive step (IS)	Yes:	Claims	6-10
	No:	Claims	1-5

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Industrial applicability (IA)    Yes:    Claims    1-10  
   No:    Claims

2. Citations and explanations  
    **see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Reference is made to the following documents:**

D1: US-A-4 332 509 (R. REYNARD)  
D2: GB-A-2 188 394 (T. JEE)

#### **IV - Lack of unity of invention**

The application lacks unity within the meaning of Rule 13 PCT for the following reasons:

The special technical features (in the meaning of Rule 13.2 PCT) of claims 1 to 5 can be summarised in that a hybrid riser configuration comprises a plurality of riser pipes which are inserted into guide-conduits in the form of a helix. The problem solved by this feature is that the guide-conduits provide a radial constraint to the riser pipe against the elastic deformation produced by thermal expansion and variations in pressure of the pipes and that no additional tethering means is required.

The special technical features of claims 6 to 10 can be summarised by the method of forming and installing a hybrid riser in order to speed up the hitherto lengthy towing and setting process.

The applicant has argued that the common technical feature linking these two sets of claims is the need for neutral buoyancy of the riser configuration in order to allow tow-out and installation, although he has also stated that this feature is not readily apparent from the wording of the two sets of claims.

Claims 1 to 5 and 6 to 10 therefore specify unrelated features which solve unrelated problems and which can be separately implemented. Furthermore, the simultaneous use of the features from both sets of claims does not result in any synergetic effect.

Therefore, no technical relationship exists between the features of the two sets of claims and they do not meet the unity requirement of Rule 13.1 PCT.

**V - Reasoned statement under Rule 66.2 (a)(ii)**

V-1.1 D1, which is considered the closest prior art document for **claim 1**, discloses: a hybrid riser configuration having a submerged tower (column 1, line 23) comprising a plurality of riser pipes (Fig.1, ref.2) substantially inserted in guide-conduits (Fig.1, ref.4), and also having buoyancy means (column 1, lines 36-37) and tethering tension means (column 1, lines 37-38, where the tensioning means are also provided by the buoyancy means), the riser pipes and guide conduits being connected to a base anchored on the ocean floor (column 1, lines 34 -35), wherein a plurality of the guide-conduits are acting as multiple tethers (column 3, lines 15-18).

D1 does not specify whether each guide-conduit acts as a radial constraint in elastic deformation (Euler) of the riser pipe inside, and therefore the corresponding feature and subject-matter of claim 1 is new and the claim meets the corresponding requirement of Art. 33(2) PCT.

V-1.2 The skilled man, in trying to put into practice the teaching of D1, is confronted with the problem of limiting the stresses induced on the riser pipes by changes in temperature. D2 discloses that this problem can be solved by arranging each riser inside the corresponding conduit-guide in the form of a helix, whereby the conduit acts as a radial constraint for the riser (lines, 82-85 and Fig.2 compared with Fig.3). It would be an obvious solution for the skilled man to arrange the risers in such a way, even if D2 relates to a horizontal pipe bundle, as is argued by the applicant, although the problems to be overcome are the same in a riser configuration. Claim 1, therefore, does not meet the corresponding requirement of Art. 33(3) PCT.

The applicant has also argued that the configuration of D1 consists only of a central guide conduit that is provided with reinforced traction sheathing whereas claim 1 of D1 states that **at least one** of the said internal conduits comprises a tube having a reinforced sheathing **able to sustain the effects of longitudinal traction** and therefore the plurality of reinforced conduits in D1 would therefore be able to be utilised as multiple tethers.

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- V-2 Dependent **claims 2 to 5** do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to Art. 33(3), the reasons being as follows:
- V-2.1 The additional feature specified in **claim 2** is disclosed in D1 where a series of riser conduits are rigidly connected together indicating that the complete sections themselves have a rigid attachment to the buoyancy means and the base means. D2 also discloses the rigid connection of the pipe bundle (both guide-conduit and riser pipe) to the sea-floor base or template (see lines 49-50).
- V-2.2 Although the applicant has argued that the use of aluminium or a similar light metal, as specified in **claim 3**, would be economically viable in the current configuration, it is considered that the skilled man, given the availability of a range of materials and knowledge of the problems of corrosion that can arise from the mixing of materials (see also V-2.3 of this report), would select the most optimum material or materials in order to solve this problem.
- V-2.3 The use of sacrificial anodes as specified in **claim 4** is well known in the offshore drilling industry particularly where sub-sea structures are constructed from a variety of metals which have a potentially corrosive interaction.
- V-2.4 **Claim 5** is unclear (see Section VIII of this Report).
- V-3 D1, which is also considered the closest prior art document for **claim 6**, discloses:  
a riser apparatus having a submerged tower (column 1, line 23) comprising a plurality of riser pipes (Fig.1, ref.2) substantially inserted in guide-conduits (Fig.1, ref.4), and also having a buoyancy tank (column 1, line 36-37) and gravity base (column 1, lines 34 -35) connected by said riser pipes and guide-conduits.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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D1, however, does not disclose how the riser is manufactured and subsequently towed into position. Furthermore, none of the other cited documents deal with this subject, and claim 6 meets the requirements of Art. 33(2) and (3) PCT with respect to novelty and inventive step.

V-4      **Claims 7 to 10** are dependent on claim 6 and therefore said claims also meet the requirements of Art. 33(2) and (3) PCT.

**VII - Certain defects**

VII-1      Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1 is not mentioned in the description, nor is this document identified therein.

**VIII - Certain observations (clarity)**

VIII-1      Claim 5 consists of a method statement which does not correspond to a particular feature that would allow the skilled man to carry out the specified step.

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/NO 00/00279**

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
GB	2188394	A	30/09/87	GB 8607393 D	00/00/00
				GB 8706906 D	00/00/00
GB	2330157	A	14/04/99	BR 9806610 A	25/04/00
				GB 9721258 D	00/00/00
				NO 982559 A	08/04/99
				US 6109830 A	29/08/00
EP	0200308	A1	05/11/86	AT 63604 T	15/06/91
				BR 8601931 A	06/01/87
				CA 1240566 A	16/08/88
				DE 3679229 D	00/00/00
				JP 61254713 A	12/11/86
				MX 165245 B	04/11/92
				NO 861705 A	03/11/86
				US 4646840 A	03/03/87
US	4332509	A	01/06/82	ES 492506 A	16/02/81
				ES 8102653 A	16/04/81
				FR 2459420 A,B	09/01/81
				GB 2052005 A,B	21/01/81
				NO 160389 B,C	02/01/89
				NO 801808 A	19/12/80

(19) World Intellectual Property Organization  
International Bureau



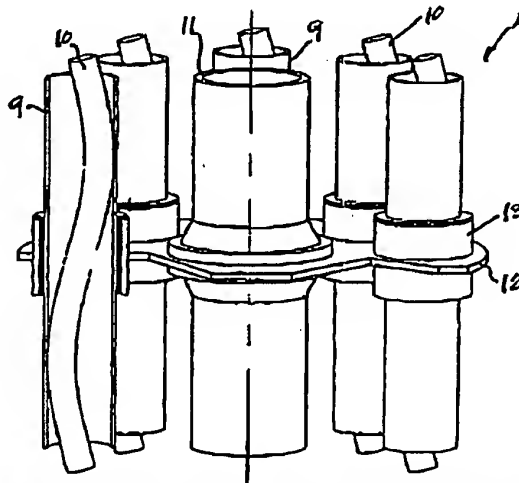
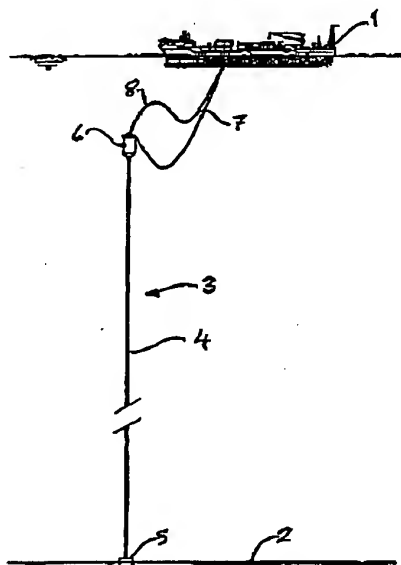
(43) International Publication Date  
1 March 2001 (01.03.2001)

PCT

(10) International Publication Number  
WO 01/14687 A1

- (51) International Patent Classification<sup>7</sup>: E21B 17/01, 43/01
- (21) International Application Number: PCT/NO00/00279
- (22) International Filing Date: 24 August 2000 (24.08.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
19994094 24 August 1999 (24.08.1999) NO
- (71) Applicant (for all designated States except US): AKER RISER SYSTEMS AS [NO/NO]; Postboks 246, Lilleaker, N-0216 Oslo (NO).
- (72) Inventors; and  
(75) Inventors/Applicants (for US only): SELE, Arne [NO/NO]; Haresvingen 10, N-1362 Høslø (NO). NYGÅRD, Magne [NO/NO]; Tappen 12, N-1337 Sandvika (NO).
- (74) Agent: OSLO PATENTKONTOR AS; Postboks 7007 M, N-0306 Oslo (NO).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KR (utility model), KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:  
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A HYBRID RISER CONFIGURATION



(57) Abstract: Hybrid riser configuration comprising a plurality of steel riser pipes (10) substantially inserted in aluminium guide conduits (9), with buoyancy means (6) and tethering tension means, the guide conduits (9) and the riser pipes (10) being rigidly connected to a base (5) anchored to the ocean floor. The guide conduits (9) serve as the tethering tension means and as radial constraint for the respective riser pipe (10) therein to allow the riser pipe to buckle in elastic deformation (Euler) to form a spiral when expanding due to service pressure and temperature. A method for installing the riser configuration is also disclosed.

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# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>140698/LS/KR</b>	<div style="display: flex; justify-content: space-between;"> <div> <b>FOR FURTHER ACTION</b> </div> <div>           See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)         </div> </div>	
International application No. <b>PCT/NO00/00279</b>	International filing date (day/month/year) <b>24/08/2000</b>	Priority date (day/month/year) <b>24/08/1999</b>
International Patent Classification (IPC) or national classification and IPC <b>E21B17/01</b>		
Applicant <b>AKER RISER SYSTEMS AS et al.</b>		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 8 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li>I <input checked="" type="checkbox"/> Basis of the report</li> <li>II <input type="checkbox"/> Priority</li> <li>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li>IV <input checked="" type="checkbox"/> Lack of unity of invention</li> <li>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li>VI <input type="checkbox"/> Certain documents cited</li> <li>VII <input checked="" type="checkbox"/> Certain defects in the international application</li> <li>VIII <input checked="" type="checkbox"/> Certain observations on the international application</li> </ul>		
Date of submission of the demand  <b>08/02/2001</b>	Date of completion of this report  <b>10.12.2001</b>	
Name and mailing address of the international preliminary examining authority:  <div style="display: flex; align-items: center;"> <div>             European Patent Office              D-80298 Munich              Tel. +49 89 2399 - 0 Tx: 523656 eprmu d              Fax: +49 89 2399 - 4465           </div> </div>	Authorized officer  <b>Morrish, S</b>  Telephone No. +49 89 2399 7220	



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NO00/00279

## I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):
- Description, pages:

1-9 as originally filed

### Claims, No.:

1-10 as originally filed

### Drawings, sheets:

1/5-5/5 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/NO00/00279

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):  
(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

**IV. Lack of unity of invention**

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.  
☐ paid additional fees.  
☐ paid additional fees under protest.  
☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.  
☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.  
☐ the parts relating to claims Nos. .

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims 1-10
	No: Claims
Inventive step (IS)	Yes: Claims 6-10
	No: Claims 1-5

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Industrial applicability (IA)    Yes:    Claims    1-10  
   No:    Claims

2. Citations and explanations  
see separate sheet

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
see separate sheet

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
see separate sheet

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/NO00/00279

Reference is made to the following documents:

D1: US-A-4 332 509 (R. REYNARD)

D2: GB-A-2 188 394 (T. JEE)

**IV - Lack of unity of invention**

The application lacks unity within the meaning of Rule 13 PCT for the following reasons:

The special technical features (in the meaning of Rule 13.2 PCT) of claims 1 to 5 can be summarised in that a hybrid riser configuration comprises a plurality of riser pipes which are inserted into guide-conduits in the form of a helix. The problem solved by this feature is that the guide-conduits provide a radial constraint to the riser pipe against the elastic deformation produced by thermal expansion and variations in pressure of the pipes and that no additional tethering means is required.

The special technical features of claims 6 to 10 can be summarised by the method of forming and installing a hybrid riser in order to speed up the hitherto lengthy towing and setting process.

The applicant has argued that the common technical feature linking these two sets of claims is the need for neutral buoyancy of the riser configuration in order to allow tow-out and installation, although he has also stated that this feature is not readily apparent from the wording of the two sets of claims.

Claims 1 to 5 and 6 to 10 therefore specify unrelated features which solve unrelated problems and which can be separately implemented. Furthermore, the simultaneous use of the features from both sets of claims does not result in any synergetic effect.

Therefore, no technical relationship exists between the features of the two sets of claims and they do not meet the unity requirement of Rule 13.1 PCT.

**V - Reasoned statement under Rule 66.2 (a)(ii)**

V-1.1 D1, which is considered the closest prior art document for **claim 1**, discloses: a hybrid riser configuration having a submerged tower (column 1, line 23) comprising a plurality of riser pipes (Fig.1, ref.2) substantially inserted in guide-conduits (Fig.1, ref.4), and also having buoyancy means (column 1, lines 36-37) and tethering tension means (column 1, lines 37-38, where the tensioning means are also provided by the buoyancy means), the riser pipes and guide conduits being connected to a base anchored on the ocean floor (column 1, lines 34 -35), wherein a plurality of the guide-conduits are acting as multiple tethers (column 3, lines 15-18).

D1 does not specify whether each guide-conduit acts as a radial constraint in elastic deformation (Euler) of the riser pipe inside, and therefore the corresponding feature and subject-matter of claim 1 is new and the claim meets the corresponding requirement of Art. 33(2) PCT.

V-1.2 The skilled man, in trying to put into practice the teaching of D1, is confronted with the problem of limiting the stresses induced on the riser pipes by changes in temperature. D2 discloses that this problem can be solved by arranging each riser inside the corresponding conduit-guide in the form of a helix, whereby the conduit acts as a radial constraint for the riser (lines, 82-85 and Fig.2 compared with Fig.3). It would be an obvious solution for the skilled man to arrange the risers in such a way, even if D2 relates to a horizontal pipe bundle, as is argued by the applicant, although the problems to be overcome are the same in a riser configuration. Claim 1, therefore, does not meet the corresponding requirement of Art. 33(3) PCT.

The applicant has also argued that the configuration of D1 consists only of a central guide conduit that is provided with reinforced traction sheathing whereas claim 1 of D1 states that **at least one** of the said internal conduits comprises a tube having a reinforced sheathing **able to sustain the effects of longitudinal traction** and therefore the plurality of reinforced conduits in D1 would therefore be able to be utilised as multiple tethers.

- V-2      D pendent **claims 2 to 5** do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to Art. 33(3), the reasons being as follows:
- V-2.1      The additional feature specified in **claim 2** is disclosed in D1 where a series of riser conduits are rigidly connected together indicating that the complete sections themselves have a rigid attachment to the buoyancy means and the base means. D2 also discloses the rigid connection of the pipe bundle (both guide-conduit and riser pipe) to the sea-floor base or template (see lines 49-50).
- V-2.2      Although the applicant has argued that the use of aluminium or a similar light metal, as specified in **claim 3**, would be economically viable in the current configuration, it is considered that the skilled man, given the availability of a range of materials and knowledge of the problems of corrosion that can arise from the mixing of materials (see also V-2.3 of this report), would select the most optimum material or materials in order to solve this problem.
- V-2.3      The use of sacrificial anodes as specified in **claim 4** is well known in the offshore drilling industry particularly where sub-sea structures are constructed from a variety of metals which have a potentially corrosive interaction.
- V-2.4      **Claim 5** is unclear (see Section VIII of this Report).
- V-3      D1, which is also considered the closest prior art document for **claim 6**, discloses:  
a riser apparatus having a submerged tower (column 1, line 23) comprising a plurality of riser pipes (Fig.1, ref.2) substantially inserted in guide-conduits (Fig.1, ref.4), and also having a buoyancy tank (column 1, line 36-37) and gravity base (column 1, lines 34 -35) connected by said riser pipes and guide-conduits.

D1, however, does not disclose how the riser is manufactured and subsequently towed into position. Furthermore, none of the other cited documents deal with this subject, and claim 6 meets the requirements of Art. 33(2) and (3) PCT with respect to novelty and inventive step.

V-4      **Claims 7 to 10** are dependent on claim 6 and therefore said claims also meet the requirements of Art. 33(2) and (3) PCT.

**VII - Certain defects**

VII-1      Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1 is not mentioned in the description, nor is this document identified therein.

**VIII - Certain observations (clarity)**

VIII-1      Claim 5 consists of a method statement which does not correspond to a particular feature that would allow the skilled man to carry out the specified step.